EFI Workshop on Forest sector modelling

The French Forest Sector Model 2.0 (FFSM++)

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Objectives

Given the importance of anthropogenic determinants in forest growth within Europe, the objective of FFSM++ is to link the evidence arising from biological models with socio-economic determinants, where the expected returns of forest investments represent the main drivers.

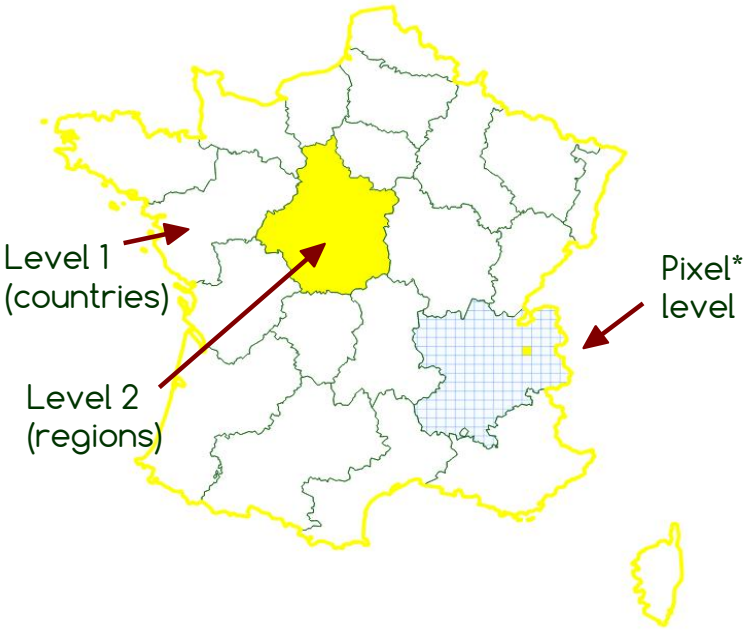
Hence first an adequate spatial scale is adopted to facilitate models linkage and then a management module is introduced to account for possible variations in forest investments.

With both biological and economic drivers considered we can try to:

- understand the impact of forward-looking vs conservative forest management;
- forecast the impact of climate change on forest profitability, depending on forest managers strategies;
- forecast the long-term evolution of the French land-use, comparing forests and agriculture profitability.

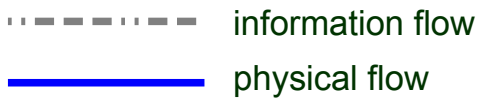
Spatial representation

- Decoupling the spatial scale of the market module (regional) from those of the resource and management modules (pixel)
  - regional scale reasonably adequate for the market module
- Consistency with vegetation growth models:

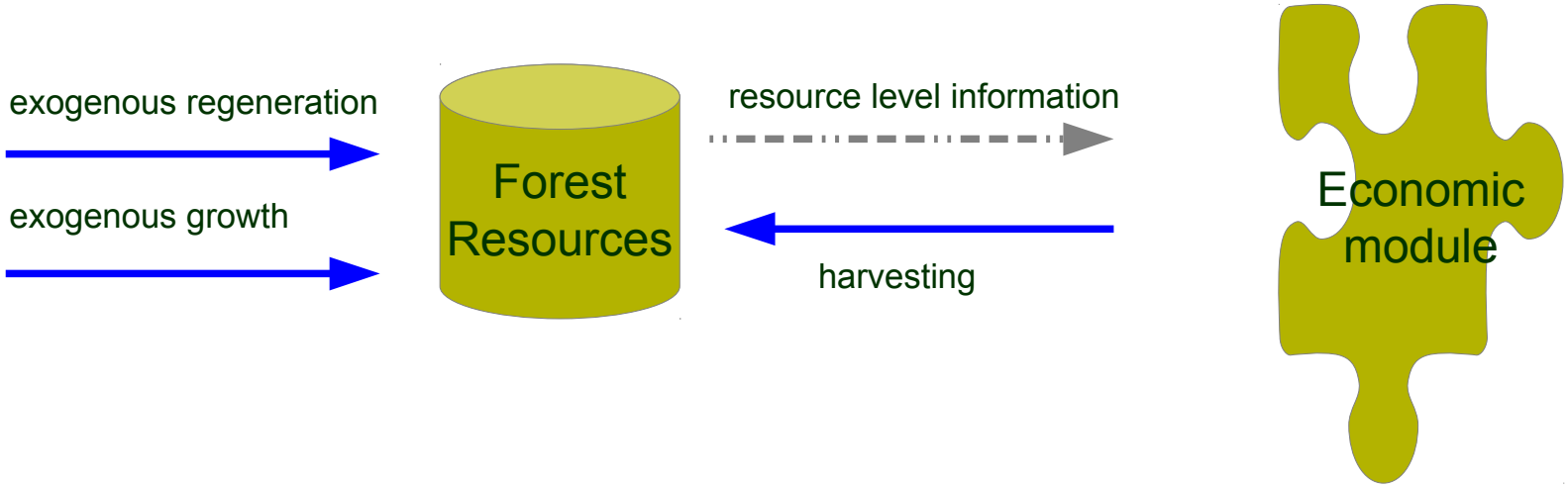


Module	Spatial Levels
Market module (KM)	Countries, regions
Resource module (RM)	Counties, regions, pixels*
Management module (GM)	Countries, regions, pixels*

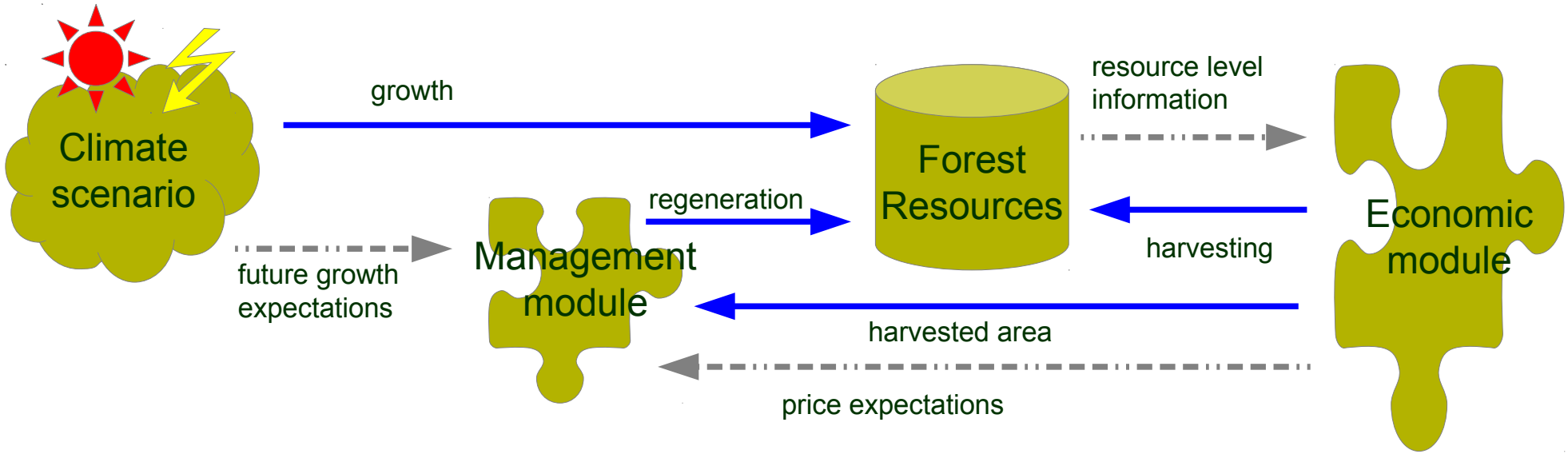
Model flowchart



FFSM 1.0:



FFSM++:



Management module (1)

- Expected returns from a given forest type depend from both (expected) market price of related wood products and (expected) biological parameters;
- converted to annualised valued ;
- each possible combination is multiplied by a weighting factor of the actual harvested for that specific combination to the total harvested for the forest type (only final harvested considered).

$$expReturns_{px,ft,t} = \sum_{dc} \sum_{pp} \frac{PW_{r,pp,t} * vHa_{px,ft,dc,t} * ponCoeff_{px,ft,dc,pp,t}}{(1+r)^{(cumTp_{px,dc,t}-1)} + (1+r)^{(cumTp_{px,dc,t}-2)} + \ldots + (1+r)^{(cumTp_{px,dc,t}-cumTp_{px,dc,t})}}$$

$$ponCoeff_{px,ft,dc,pp,t} = \frac{hv_{px,ft,dc,pp,t} * finHrFlag_{ft,dc}}{\sum_{dc} \sum_{pp} hv_{px,ft,dc,pp,t} * finHrFlag_{ft,dc}}$$

- Each year an harvested area for each f.t. is computed from the harvested volumes (in turn derived from market demand)

$$harvestedArea_{px,ft,dc,t} = hV_{px,ft,dc=finharv,t} / vHa_{px,ft,dc,t}$$

Management module (2)

- The regeneration area for each forest type is equal to the unmanaged share of the harvested area of its own type ;
- the managed share of the total harvested area is allocated as the regeneration area of the forest type having the highest expected return ($\check{ft}$).

$$regArea_{px,ft,t} = \sum_{dc} harvestedArea_{px,ft,dc,t} * (1 - mr)$$

$$regArea_{px,\mathring{ft},t} \mathrel{+}= \sum_{ft} \sum_{dc} harvestedArea_{px,ft,dc,t} * mr$$

- A time leg exists between harvesting/regeneration and availability of wood resources

$$vReg_{px,ft,t} = regArea_{px,ft,\tau} * vHa_{px,ft,dc15,\tau}$$

$$\tau = t - tp_{px,ft,dc0,t}$$

Linking different type of models has its “costs”..

- Biological models ==> scientific languages (C, FORTRAN, python..)
- Economic (market) models ==> some specialised optimisation language (GAMS, AMPL)

We choose to code FFSM++ in a general-purposes programming language using specialised (open source) libraries when needed:

- Core of the model: C++
- Non-linear constrained optimisation library: IPOPT (ADOL-C, ColPack)
- Graphical front-end: Qt (but also batch mode for “what if” scenarios)
- GIS input data: GRASS

Advantages:

- tailored input/output

- code re-usability and readibility (functions)

- flexibility (e.g. hierarchical sets)

Upcoming work

- Testing the spatial module working with the spatial/temporal multipliers (from ORACLE project);
- Integration of other local, sub-regional characteristics (e.g. slope → available wood resources);
- Recognition of forest owner heterogeneity (different risk attitude);
- More sensitivity analysis and validation exercises;

Merci pour votre attention

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